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DIMENSIONS NBS

COMPUTER TECHNOLOGY AT NBS

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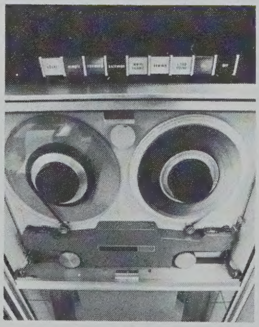

Computers have become a way of life in the United States. This issue of DIMENSIONS/NBS takes a look at NBS' role in improving the effectiveness of computer utilization.

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The National Bureau of Standards serves as a focal point in the Federal Government for assuring maximum application of the physical and engineering sciences to the advancement of technology in industry and commerce. For this purpose, the Bureau is organized as follows:

The Institute for Basic Standards
The Institute for Materials Research
The Institute for Applied Technology
The Institute for Computer Sciences and Technology
Center for Radiation Research
Center for Building Technology
Center for Consumer Product Safety

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COMPUTER TECHNOLOGY AND NBS

THE electronic computer may be man's most spectacular and sophisticated technological development. Certainly, it is one of our most indispensable tools. Without the computer, we could not have gone to the moon, banks could not handle the 23 billion checks we write each year, we would be overwhelmed by the decennial census and the Social Security system, and the advance of science would be markedly slowed.

Computers are our only means of processing information in the volume and at the speed necessary to permit governments to meet their responsibilities for providing public services. Our dependence on the computer is still growing rapidly as we search for new ways to solve national problems and satisfy the Nation's demand for services.

NBS Roles in Computer Technology

In the quarter century since NBS built SEAC (Standards Eastern Automatic Computer), one of the Nation's very first electronic computers, computer technology has had an explosive growth. The 1952 vintage computer power represented by a roomful of vacuum tubes is now contained in a handful of miniaturized chips (small pieces of semiconductor material). Some of today's computers, as compared with the UNIVAC I (1952), have 700 times the storage capacity, execute additions 4000 times faster, and boast main memory cycle speeds that are greater by 1000 times. Computer speed, capacity and reliability have increased tremendously while size and cost per operation have dropped dramatically.

There are currently more than 110,000 computers in the United States. They are used in more than 2000 different types of applications encompassing manufacturing, retail and wholesale trade, finance, government, transportation and utilities, education and health care. There is hardly any sector of the economy that does not use computers. Virtually every citizen is affected or served by some type of computer service. The computer industry is now the 8th largest in the United States. The combination of computer and communication extend computer power to any place there is a telephone.

Computer Problems to be Solved

Although the advance of computer hardware technology has been revolutionary, our ability to apply the technology effectively has not kept pace. Efforts to exploit the full potential of the computer are often impeded by serious, costly problems related to:

- the lack of computer security procedures.

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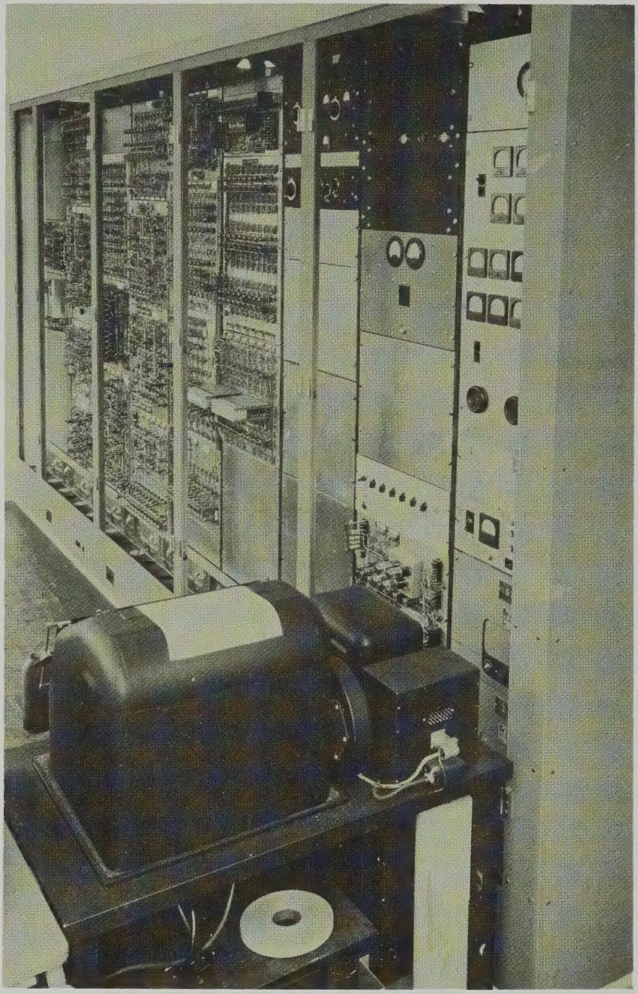

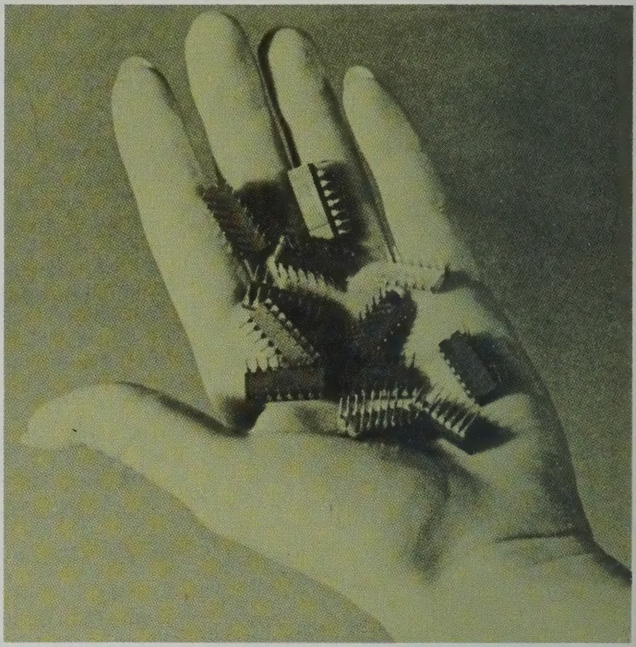

The capabilities of the first-generation computers can now be equaled by a handful of semiconductor material.

- an inability to efficiently produce high-quality software.
- the lack of adequate standards.
- an uneven and insufficient diffusion of computer technology.
- the difficulty and expense of developing specific applications.
- the lack of effective methods for measuring computer system performance and the quality of services.

These are pervasive problems that affect the public and the private sectors alike.

From the early days of its focus on hardware technology, the National Bureau of Standards is now increasingly concentrating on the development of ways to improve the effectiveness of computer utilization. The Bureau's computer technology program is carried out by the Institute for Computer Sciences and Technology (ISCT). The Institute has responsibility under its basic charter, Public Law 89-306, to develop mandatory Federal Information Processing Standards, provide technical assistance and advice to Federal departments and agencies and conduct necessary research in computer science and technology.

ICST Program Objectives

Within the overall NBS mission, the Institute's objectives are to strengthen and diffuse computer science and technology and foster their application for public benefit. These objectives are accomplished through a comprehensive technical program that stresses high-priority national computer problems and issues.

The Institute places great emphasis on continuous interaction with Federal agencies, State and local governments, the computer industry, academia, professional societies and trade associations, national standardization bodies and special interest communities in the private sector. These interactions are a useful mechanism for sharpening the identification and definition of problems, integrating and reenforcing related technical efforts and interests and achieving a much needed diffusion of computer technology.

Computer Standards

Computer standards are among the Institute's most important products. To date, it has produced and issued 23 Federal Information Processing Standards (FIPS): about two-thirds of these are in the hardware category. In addition to its work on Federal standards, the Institute participates in, or coordinates Federal participation in, some 65 committees of the American National Standards Institute. ICST is also working closely with special interest communities such as the retail industry to develop standards that will foster the diffusion and introduction of computer and automation technology within the community.

NBS Help to Other Agencies

NBS has a long tradition of helping others apply technology. The impact of this tradition has been particularly significant in the computer field. Starting with the early assistance to Federal agencies in developing applications for SEAC, the Bureau has continued to help agencies make sophisticated use of computer technology. For example, in 1972 ICST developed, as an adaptation of the automated fingerprint identification system designed for the FBI, a computer-based footprint identification system for the President's Special Action Office on Drug Abuse Prevention. In June of this year, the Institute delivered to the Internal Revenue Service a unique, automated prototype system for processing taxpayers' remittances that will increase efficiency and productivity. ICST currently has active projects with 20 Federal agencies.

Finally, the Institute provides continuous technical inputs and advice to the Office of Management and Budget and the General Services Administration to support the formulation of government-wide ADP (automated data processing) management and procurement policies. ☐

Phil Shupe, NBS Technical Project Leader, shows IRS employees how the NBS prototype for processing taxpayer remittances operates.

AUTOMATION TECHNOLOGY

NBS EMPHASIS ON SOFT AUTOMATION

The pincer hands of a robot mimic Dr. James Albus' movements. NBS aims at activating such devices with computers.

THE National Bureau of Standards Institute for Computer Sciences and Technology (ICST) established an automation technology program in 1972 aimed at stimulating research in automation, accelerating its introduction and encouraging its diffusion in the economy.

The key to successful automation is the effective control of the machines that manufacture, handle and vend goods and services. In effect, we have to give machinery a few human qualities such as crude manipulatory skills and some intelligence. So far, American industry has concentrated on what is called "hard" automation, where machines are controlled by orders stored in permanent form in mechanical cams, gears and levers and in fixed electronic circuits. Hard automation is extremely effective in turning out millions of identical automobile parts, but it is not flexible enough for many short production runs of different items.

In contrast, "soft" automation is based on the programmable computer. Because computer programs can be changed quickly and easily, automated equipment controlled by computers is inherently more flexible and adaptable. Thus, the computer can bring the advantages of automation to the short production runs that make up a large fraction of the output of American industry. The computer also makes possible better product inspection and the custom design of products at mass-production costs. It is in the area of soft automation that ICST is best equipped to help improve automation technology.

The use of soft automation can increase productivity while reducing material and labor costs. Statistics show that the introduction of numerically controlled machine tools normally increases productivity by 300-500 percent. Industrial robots, such as the Versatran transfer machines on assembly lines, increase productivity by a factor of 10. However, by starting with computer-aided design of products and following through with computer-controlled manufacturing, productivity can probably be increased a hundredfold.

One common element of all automated systems is the control of the position and the orientation of the tools and the part being manufactured. Wih human eyes and hands, this is an easy task, but in machines it can be achieved only through the application of complex, expensive, very precise mechanical devices. To overcome these mechanical difficulties, NBS is developing sensors based on microwaves and ultrasonic waves to measure position and orientation. Such sensors promise higher precision at lower costs for machine tools and manipulators.

Some new manipulator control concepts are also being investigated. ICST is using a manipulator mounted on a test bed to explore some of these new concepts. The motions of this manipulator wil be controlled by the ICST PDP-11 research computer. With its 20 degrees of freedom, this is a unique test device for exploring the characteristics of new sensors and control systems and their applicability to industrial manufacturing and assembly.

A major obstacle to the practical application of new automation concepts has been the difficulty in measuring the effectiveness of new technological developments. With the test bed mentioned above as a practical evaluation tool, NBS is taking the lead in measuring the capabilities of new automated devices.

The Diffusion of Automation

NBS is working with the Numerical Control Society (NCS) on an experiment to promote the diffusion of automation by improving the market for this technology. NCS has received a grant from the Economic Development Administration, with matching funds from the First National Bank of Boston, to set up an information service on the available manufacturing capacity of the New England region. By improving communication between producers and suppliers, the use of existing productive capacity should be improved. NBS is assisting NCS by providing advice and standards to insure that the techniques developed in the experiment will be easily transferred to industry in the rest of the country.

Promoting Automation in the Service Industries

As vital as automation in manufacturing is to improving the Nation's productivity, it should be recognized that the United States is now a "post industrial" nation where more people work at producing services than in manufacturing goods. Automation in the service industries, such as medicine and education, is becoming more and more important every day. Automation is more difficult to achieve in the service areas because it requires transition from person-to-person contact to person-to-machine contact.

To help assess the roles of computers in the service industries, ICST, in cooperation with the Engineering Foundation Conference, sponsored a meeting at New England College, Henniker, New Hampshire, in August 1973. Over 70 leaders from business, government and academic institutions attended. Workshop panels considered the requirements and capability for automation in the services and the direction computer technology must take if automation is to be effective. The results and proceedings of the Henniker conference will be published in early 1974. ☐

CORRECTION: On page 231 of the October DIMENSIONS/NBS the headings of the second and fourth columns in the table should be corrected to $\mu g/m^3$. In the first paragraph on page 235, the units in parentheses should be ppb. The editor regrets these errors.

TERMINOLOGY

Privacy: a concept which applies to individuals. It is the right of an individual to decide what information about himself he wishes to share with others and also what information he is willing to accept from others. The resolution of privacy issues will have to be achieved through legal channels and is not primarily within the purview of controlled accessibility.

Confidentiality: a concept which applies to data. It is the status accorded to data which has been agreed upon between the person or organization furnishing data and the organization receiving it. It describes the degree of protection which will be provided. It is the confidentiality of data that requires protection, not the privacy.

Security: is the protection of hardware, software and data through the imposition of appropriate safeguards. Security comprises data security, the protection of data against accidental or intentional destruction, disclosure or modification using both physical security measures and controlled accessibility; physical security; and controlled accessibility, the set of technological measures of hardware and software available in a computer system for the protection of data.

IMPROVING COMPUTER UTILIZATION

OVERCOMING OBSTACLES TO EFFECTIVE UTILIZATION

THE computer science and technology program of the National Bureau of Standards is aimed at improving the utilization of computer technology within both the Federal government and the private sector. The program has the specific objectives of overcoming the widespread, technologically based computer problems that most seriously impede the effective use of computers.

The core problems being addressed by NBS come from a variety of sources that extend far beyond the interests of computer professionals. Some of the major sources are:

- Congressional hearings and legislation outside the computer area but having a significant peripheral impact on computer technology usage.
- Reports of the United States General Accounting Office.
- Information provided by consumer groups and better business bureaus.
- Information provided by the computer services industry.
- Special investigative panels and study groups.

Collectively, these and other sources have both identified problem areas and helped provide an understanding of the dimensions and severity of the problems.

Controlled Accessibility

A major problem in the widespread uses of computer technology is the lack of effective means to safeguard computerized information and insure the individual's right to privacy. The issue has been described as one of the most vexing problems of our post-industrial society: How to resolve the mounting conflict between the three-fold demands for individual privacy, free access to government information and the protection of information from destruction or misuse.

The problem is rooted in the present trend toward collecting and storing a large amount of information about individuals and then using it for a number of different purposes. The issue of individual privacy in the use of information has not resulted from the development of the computer, but the heightened interest in privacy *can* be attributed to the capability of the computer for storing vast amounts of usable data.

The NBS computer security program is focused principally on the development of standards and guidelines for controlling access to computers and the specifications of appropriate levels of protective assurance required for various classes of operating environments. ICST is carrying out this program in collaboration with computer and management specialists from various agencies of Federal, state and local governments. Also participating are professional and trade associations, public interest groups and computer hardware and software companies.

Software Management

Without question, the inability to produce high-quality computer software is one of the most crucial obstacles to the effective use of computer technology. The development of software is the most costly aspect of computer utilization and generally is the least precise of all data processing functions. The techniques for producing software have not come close to keeping pace with our technology of designing and producing sophisticated computer hardware. Moreover, since software is the key to the effective use of computer hardware, this inability to produce high-quality software severely limits the development of good applications and contributes to the waste of available computing capacity.

The computer software marketplace has no parallel in the economy. It is a marketplace where there are no conventional safeguards to protect the buyer. The computer user must buy software without any assurance that it is free of errors or that is is certified for optimimun efficiency under stated operating conditions. Software also frequently lacks adequate documentation to allow the user to correct or modify it. In short, the software marketplace functions without benefit of industry-wide performance standards or measures to protect both the buyer and the seller.

ICST is conducting a software management program that encompasses performance standards and measurements, software testing, certification, maintenance transferability, documentation and controlled accessibility. The Institute's goals are:

- The development and application of quality-control techniques for use in the production of software.
- The development of software documentation standards.
- The development of more efficient methods of producing software.
- The development of methods for measuring the performance of software and testing it against quality-control and documentation standards.

Computer Networking

Computer networking is the interconnection of computers and users with telecommunications. Networks offer a practical means for sharing

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Amory Erickson of NBS Information Processing Technology Division demonstrates equipment used to calibrate standard magnetic tapes. In foreground is magnetic cassette testing station.

expensive information resources, for computing resources and information handling equipment and for providing equality of access to and equality of quality in public services, independent of geographical location. Computer networking is no longer a technological novelty but is now possibly the most rapidly growing form of computer utilization.

One element of ICST's technical program is directed at resolving the most pressing problems of computer network design and utilization. A portion of the program is aimed at developing effective methods for measuring the performance of computer networks. ICST has already developed a unique network measurement machine, a combination of hardware and software for monitoring, recording and analyzing quantitative data descriptive of the interaction between the user and the computer system. The output of the network measurement machines is a quantitative measure of the performance of the computer system and its associated communications under specific operating conditions. The Institute is also developing a terminal environment simulator to be used in conjunction with the network measurement machine. The simulator will permit the controlled loading of a network so that performance can be measured under a variety of load conditions.

ICST's computer networking program is also aimed at developing definitive guidelines for evaluating alternative ways of effectively sharing information and information processing resources through computer networks. This effort includes the design of network access software to be incorporated into intelligent terminals that will give users more convenient access to multiple computer networks with a minimum of disruption and delay from differences in communications formats and usage protocols.

Finally, the Institute will develop Federal guidelines for evaluating alternative approaches to data communications in support of computer networks and for the interconnection of networks. Guidelines are also being developed to enable agencies to exploit more fully hierarchical network configurations and provide more efficient support of clusters of terminals, manufacturing and process control operations, laboratory automation and other applications.

Don E. Rippy, foreground, Robert Rosenthal, center and Thomas N. Pyke, Jr., use the Bureau's terminal interface message processor to connect into a major Department of Defense computer network.

The Institute maintains and operates a Terminal Interface Message Processor (TIP) that provides access to the Department of Defense's ARPA (Advanced Research Projects Agency) Network. Through the TIP, ICST is able to use the ARPANET as a testbed for its computer network activity and to provide a convenient entry point for Federal agencies wanting to access the ARPANET.

Performance Measurement

Computer technology is an area with very little developed capability to measure the performance of computer products and services. This deficiency adversely affects all facets of computer utilization from selection and acquisition through operations. The ICST is conducting a comprehensive technical effort to overcome this deficiency by developing an effective set of computer system performance measurement and evaluation tools and methodologies.

The ICST program encompasses the verification of simulation and benchmarking as tools for use in the computer selection process, the development of characterizations of computer system capacity and utilization and the formulation of guidelines for the use of computer system hardware and software performance monitors.

The Institute is also stressing the development of magnetic media calibration and reference techniques and standards. This work is an extension of the Institute's Standard Reference Material 3200—Secondary Standard Magnetic Tape (Computer Amplitude Reference) which is being used as the world-wide standard for quality control in the production of computer magnetic tape. The objectives of the current work are to produce a Secondary Standard Digital Cassette (Computer Amplitude Reference); a Secondary Standard Magnetic Tape Cartridge as an NBS Standard Reference Material; and the development of calibration and reference services for both rigid and flexible disks. □

COMPUTERS
IN INTERNATIONAL TRADE

The export of computers has contributed favorably to the U.S. balance of trade over the past 3 years.

THE needs of Communist-bloc nations for computers to improve governmental efficiency and industrial productivity are critical, but the computer industry in these countries is surprisingly small and far behind that of the free world.

U.S. computer exports have exceeded imports by over $1 billion for the past 3 years. Promotion of these exports, particularly to the markets of Eastern Europe, Russia and the Peoples Republic of China could make a major contribution to the overall U.S. balance of trade. Trade with these nations is also important, of course, because of its role as a part of U.S. foreign relations. However, due to the unusual value of computers in military and scientific applications, the United States must temper its desire for increased trade with maintenance of our national security.

Export control procedures and rules were formerly based on what we in the U.S. felt was necessary for our own national defense and security functions. This policy is no longer workable for a number of reasons. Most computers are by nature "general-purpose" devices, making it difficult to categorize computer systems according to their usefulness in strategic applications. The use of computers in the design of nuclear weapons, in the control and guidance of missiles and in the decoding of intelligence data is not very different from computations performed in commercial situations. Today, the value added to a country's national strength by a new specific computer capability must be determined on a case-by-case basis.

The National Bureau of Standards' Institute for Computer Science and Technology (ICST) is taking the lead in seeking solutions to computer problems that will enable the Department of Commerce to set criteria for controlling the export of technology to Communist-bloc countries. To be effective, the trade policy must:

- Permit the computer industry to serve these markets.
- Provide for trade as a strengthener of international relations.
- Assure protection of national security.

The technical problems center around three principal questions:

1. What criteria should be used to categorize computer systems for export control purposes?

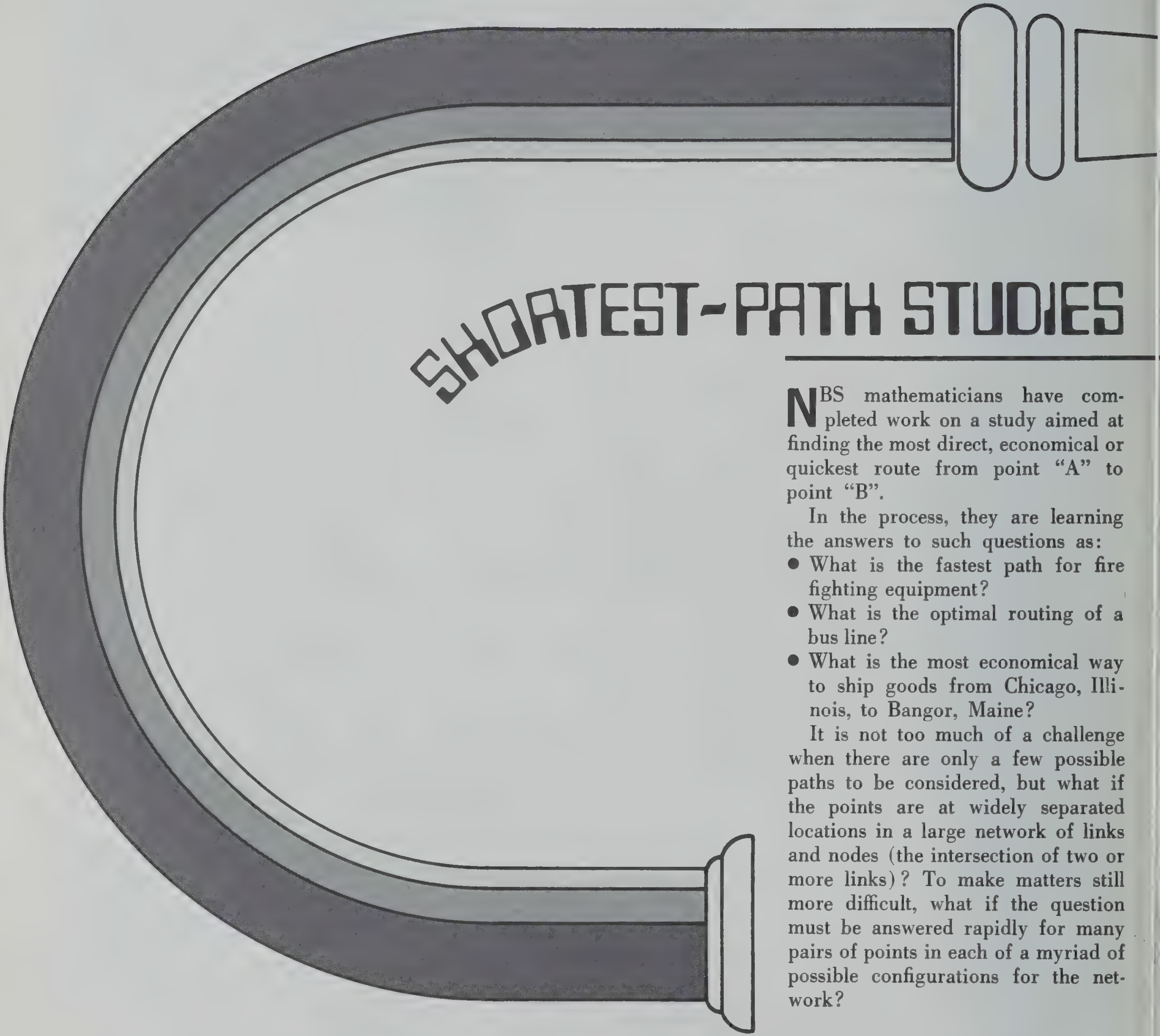
2. What countermeasures should be employed to inhibit, if not prevent, diversion of exported computer systems to strategic use?

3. What export controls, if any, should be applied to computer system software?

ICST's programs are concerned with the development of "safeguards"—techniques to inhibit the diversion of a computer system for uses other than those for which it was originally exported. To be effective, these safeguards must be difficult to foil yet inexpensive to implement.

The Institute is providing technical assistance to the Office of Export Control in the review of license applications and is contributing to the reformulation of export control policies, principally through its participation in the Technical Advisory Committees on Computer Systems and Computer Peripherals. The Institute also serves as a point of technical contact for industry in its communications with the Department of Commerce concerning the issues and details related to export license reviews.

Although the likelihood of achieving definitive technical solutions to any of these problems is small for the near future, current computer science and technology can be applied to effect significant improvements in present policies and procedures. ☐



SHORTEST-PATH STUDIES

NBS mathematicians have completed work on a study aimed at finding the most direct, economical or quickest route from point "A" to point "B".

In the process, they are learning the answers to such questions as:

- What is the fastest path for fire fighting equipment?
- What is the optimal routing of a bus line?
- What is the most economical way to ship goods from Chicago, Illinois, to Bangor, Maine?

It is not too much of a challenge when there are only a few possible paths to be considered, but what if the points are at widely separated locations in a large network of links and nodes (the intersection of two or more links)? To make matters still more difficult, what if the question must be answered rapidly for many pairs of points in each of a myriad of possible configurations for the network?

HOW TO GET THERE EFFICIENTLY

Such problems tax not only the human mind, but even the capabilities of modern high-speed computers. Their complexity created a need for the careful theoretical and "experimental" study recently completed by NBS to determine which of the numerous current computerized solution methods (algorithms) are best suited to particular types of networks.

Questions about which of many possible paths between two points is "best" (i.e., shortest, quickest, cheapest, or safest) are very much more than mere brain teasers. Their practical importance is illustrated by the fact that an estimated 300 million of these determinations are calculated annually, in such contexts as:

- Highway and traffic planning.
- Finding shortest railroad routes for freight shipments.
- Routing of military or emergency relief airlifts.
- Laying out of evacuation patterns in disaster contingency plans.
- Design of economical high-performance communication networks.

Inquiries about the NBS research have come not only from universities in all parts of the United States, but also from varied industrial sectors (such as optical, petrochemical, computer and aerospace) as well as from foreign sites ranging from Stellenbosch, South Africa, to Woolongong, Australia.

The study, conducted by Judith Gilsinn and Dr. Christoph Witzgall of the Bureau's Applied Mathematics Division, began with 30 proposed solution methods. This number was reduced by half by preliminary analysis and was compressed still further through initial computer testing. More intensive testing and analysis of the remaining candidates led finally to recommendation of three algorithms: one of them requires the least calculation time for networks with compartively short links, one is the fastest on longer linked networks and the third is the least demanding of computer memory storage.

The differences in performance can be quite dramatic. One algorithm can deliver answers 50 times faster than another one applied to the identical network—so that considerable savings can be expected from knowing which is the most efficient solution method to apply in any particular case.

The research has already proved valuable. In an NBS project for the Federal Rail Administration, roughly 21 million calculations were made in determining the shortest routes for rail freight shipments. The Gilsinn-Witzgall study permitted a five-fold reduction from the original estimate of computer time needed. Further use and dissemination of its findings should lead to similar economies on other large-scale applications of the best-path concept. □

COMPUTER STANDARDS

MEASURES FOR COMPATIBILITY AND EFFECTIVENESS

COMPUTERS are tools for achieving greater efficiency and effectiveness in performing work. Because of the large expenditures, in terms of capital investment and operating costs, associated with automatic data processing, computers themselves are the object of ceaseless efforts to improve operating efficiencies and increase economies. Standardization is a key part of the process of promoting uniformity and compatibility in computer products and services.

Data processing standards serve as a mechanism for insuring rational behavior in the computer marketplace. Standards are indicators of the phase of development or growth of a particular industry. In a young industry, such as the computer industry, one usually finds very few standards. Of the estimated 20,000 voluntary engineering standards governing the American marketplace, only about 30 are in the computer area, excluding, of course, those for equipment components such as transistors. The reason for this is that the technology and the industry are changing rapidly. The marketplace is not a mature one and does not represent a good meeting ground for buyer and seller.

However, the need for computer standards is particularly acute because the products and systems being offered in the computer marketplace are generally too complex for the ordinary customer to form his own value judgments of the products and services he needs.

NBS—The Leader in Federal Computer Standards

Since enactment of PL 89-306 in 1965, the National Bureau of Standards has been the Federal focal point for the development of computer standards. The Bureau has a dual responsibility in the computer standards area: It develops and recommends mandatory Federal Information Processing Standards (FIPS) and it also coordinates Federal participation in the development of voluntary industry standards.

To date, NBS has developed and issued 23 Federal Information Processing Standards. Fourteen of these are in the hardware category, six concern data standards and only three are software standards. In addition, NBS has issued two formal FIPS Guidelines—Registering Data Codes and Describing Information Interchange Formats.

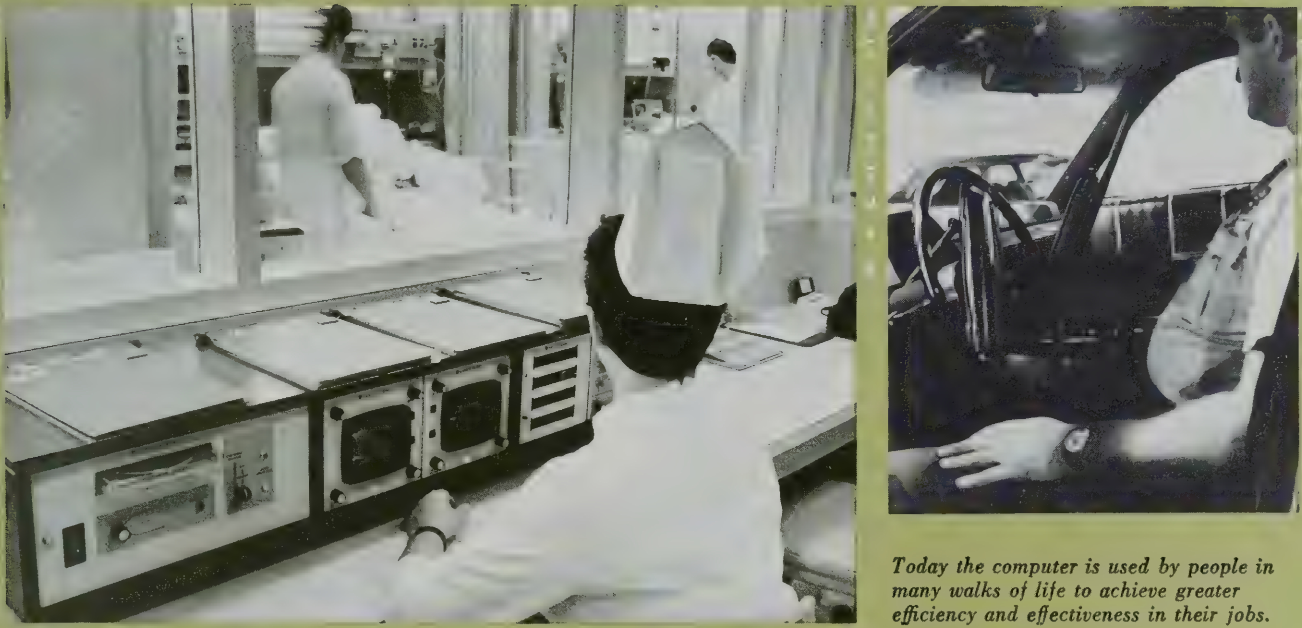
The NBS Institute for Computer Sciences and Technology currently plans to complete development of some 18 additional Federal Information Processing Standards over the next 2 years.

The major components of the Institute's standardization program encompass standards for:

- Data, Programs and Components
- Data Communications
- Computer Performance
- Applications and Data
- Management, Personnel and Environment
- Acquisition and Reassignment of ADP Products

Standards for Validation and Certification of Software Products

The lack of performance measurements and methods for determining



Today the computer is used by people in many walks of life to achieve greater efficiency and effectiveness in their jobs.

the compliance of computer software with a standard or reference point is a major deterrent to the effective utilization of computer technology. ICST is currently investigating means for certifying ADP software products and services. Hardware certification methods are already well developed. The certification of software, however, presents a new technical challenge to be solved by NBS and the computer industry.

The Institute, in cooperation with the Department of Defense and the General Services Administration, is in the process of initiating a government-wide validation service for COBOL (Common Business-Oriented Language) compilers. Validation, in this sense, means insuring that complied COBOL programs are in conformance with the specifications of the COBOL standard, i.e., FIPS 21. The centralized COBOL compiler validation service is the first software validation service in the world and is an adjunct of the computer system procurement process. Under the agreement governing the service, NBS is responsible for developing, maintaining and interpreting Federal ADP standards while the DOD is authorized to implement and maintain an NBS-approved comprehensive COBOL Compiler Validation System.

ICST has completed development of a FORTRAN (Formula Translation) validation system and plans to initiate a centralized FORTRAN validation service later this year.

Voluntary Standardization

ICST participates actively in the development of voluntary computer standards. This is done through direct membership on the standardization groups under the X3 Committee of the American National Standards Institute (ANSI) and by coordinating other Federal agencies' participation in such committees. Federal participation currently encompasses some 60 separate voluntary standardization efforts. In addition, the Institute participates, through ANSI, in the computer standards activities of the International Organization for Standardization (ISO).

Standards for Special Interest Communities

ICST, in concert with selected special interest communities, is playing a key role in the development of highly directed voluntary standards to increase the rate and spread of the diffusion of successful computer technology applications. This is a type of standardization that is not effectively accommodated by conventional voluntary standardization mechanisms such as exist in ANSI.

The National Retail Merchants Association, a trade association representing some 27,000 department, variety and specialty stores, is one of the special interest communities with which ICST is working. The objective of this effort is to develop voluntary standards for automated merchandise identification that will assist the effective introduction and diffusion of computer and automatic marking and reading technologies across the entire retailing industry. The technology diffusion to be fostered by these

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standards is essential to the retail industry's efforts to improve productivity and the quality of services in general merchandise distribution.

The retail standardization effort encompasses much more than just general merchandise retailers. It includes the computer industry, the manufacturers of general merchandise, tag and label makers and the manufacturers of health and beauty aids. Because of the overlap between the retail distribution of general merchandise and grocery products, there is also an interplay between these two industries.

This effort is a good example of a form of voluntary standardization that is becoming increasingly important to the rapid, beneficial spread of computer technology in the service industries. Further, this effort is particularly important as a forerunner of future voluntary standardization in an environment where there is not an extensive body of precedents and established, proven techniques and lore. ☐

FEDERAL INFORMATION PROCESSING STANDARDS

Hardware Standards

FIPS	1	Code for Information Interchange
	2	Perforated Tape Code for Information Interchange
	3–1	Recorded Magnetic Tape for Information Interchange (800 CPI, NRZI)
	7	Implementation of the Code for Information Interchange and Related Media Standards
	13	Rectangular Holes in Twelve-Row Punched Cards
	14	Hollerith Punched Card Code
	15	Subsets of the Standard Code for Information Interchange
	16	Bit Sequencing of the Code for Information Interchange in Serial-by-Bit Data Transmission
	17	Character Structure and Character Parity Sense for Parallel-by-Bit Data Communication in the Code for Information Interchange
	18	Character Structure and Character Parity Sense for Parallel-by-Bit Data Communication in the Code for Information Interchange
	22	Synchronous Signalling Rates Between Data Terminal and Data Communication Equipment
	25	Recorded Magnetic Tape for Information Interchange (1600 CPI, Phase Encoded)
	26	One-inch Perforated Paper Tape for Information Interchange
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	5	States of the United States
	6–2	Counties and County Equivalents of the States of the United States
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FIPS	11	Vocabularly for Information Processing
	21	Common Business Oriented Language (COBOL)
	24	Flowchart Symbols and Their Usage in Information Processing

WWV/WWVH Time Designation Change

WHEN January 1, 1974, rolls around, the familiar announcement of WWV and WWVH in Greenwich Mean Time (GMT) will change to Coordinated Universal Time (UTC). Because both GMT and UTC are identical times, the change should in no way affect anyone using WWV and WWVH services according to Peter Viezbicke, Chief of Frequency-Time Broadcast Services at the NBS Boulder Laboratories. UTC, more precisely, designates the reference time scale maintained and disseminated by NBS since 1958. The International Radio Consultative Committee (CCIR) recommended this change. NBS and the U.S. Naval Observatory (USNO) agreed with the recommendation.

GMT is the time at the prime meridian or zero longitude line through Greenwich, England. Sometimes called Universal Time, GMT was formerly Mean Solar Time, which is determined from the slightly irregular rotation of the earth on its axis. At places like the Royal Greenwich and the U.S. Naval Observatories, scientists calculate Mean Solar Time from sidereal time, measured by observing nightly stars crossing the meridian. Comparing these measurements at observatories around the world, scientists also compute navigators' time (UT1), which overcomes time discrepancies from the earth wobbling on its axis.

By international agreement, UTC was redefined January 1, 1972, as atomic time (based on the oscillations of the cesium atom) corrected as necessary by whole (leap) seconds to agree within 0.7 second with navigators' time. As a compromise time scale, UTC combines the constant rate of atomic time with the time of the rotating earth used for celestial navigation and astronomy. To prevent our clocks from getting badly out of step with the sun, scientists invented the leap second. ☐

HIGHLIGHTS

U.S.-U.S.S.R. Cooperative Program

Russia and the United States have agreed to exchanges of scientific information and personnel in metrology and standardization under the U.S.—U.S.S.R. Cooperative Program in Science and Technology run by the National Science Foundation. Representatives of the U.S.S.R. State Committee on Standards visited the National Bureau of Standards during the scheduled meetings of the International Organization for Standardization to conduct preliminary discussions with NBS and Department of Commerce officials and U.S. voluntary standards groups on the cooperative program. NBS Director Roberts visited several standards and other scientific laboratories in Russia in October to help assess goals of the program.

Retroreflecting Bicycle Tires

NBS has helped the Bureau of Product Safety develop a method for testing the optical properties of a new type of bicycle tire with retroreflecting sidewalls. Such tires should improve the safety of nighttime bicycling. Since the vulcanizing process affects the optical properties of the sidewall material, a method was needed for evaluating the optical performance of the materials as they appear in the finished tire.

Sizing of Patterns and Apparel

At the request of the Mail Order Association of America, the Bureau has initiated the development of two new voluntary product standards for the sizing of patterns and apparel—one for males and one for females. The standards will provide sizing systems based on body measurements for all age groups. Currently there are five sizing standards which cover boys, young men, women, girls, and infants and toddlers; the information in these standards will be incorporated into the new standard.

Burning Properties of Metals

To improve the safety of handling oxygen in industrial, aerospace and research settings, NBS Boulder is investigating the burning properties of metals in liquid and gaseous oxygen. The study will document the burning behavior of bulk metals in oxygen and statistically determine the range of conditions and reactions of combustion phenomena. The objective of the project is design of safer oxygen-handling equipment and reduction of life and property losses.

New Glass SRM

A set of two glasses, SRM 708, certified for relative-stress coefficients is now available from the Bureau's Office of Standard Reference Materials (B314 Chemistry Building, NBS, Washington, D. C. 20234). This standard is necessary to calibrate instruments used in quality control inspections of safety glasses, bottles, tempered glass windows and glass to metal seals.

Study to Aid Salmon Industry

The effects of fishery management policies on Pacific Coast salmon fisheries are being studied by NBS. Sponsored by the State of Washington and the National Marine Fisheries Service, the Bureau is expected to develop a large-scale mathematical model of the fisheries to help improve management efficiency. The State of Washington's annual salmon harvest is valued at over 100 million dollars.

Mechanical Failures to be Explored

The consequences of mechanical failure in materials, components and structures will be explored at a symposium to be held at NBS Gaithersburg on May 8-10, 1974. Sponsored by the Mechanical Failures Prevention Group, the symposium will define the problem and make recommendations for future action. For information contact Harry Burnett, B264 Materials Building, NBS, Washington, D. C. 20234. Telephone: 301/921-2811.

N.Y. Receives Standards

The State of New York recently received a 95-piece set of weights, measures, and weighing instruments under the NBS program to provide new weights and measures standards to the 50 states. At a ceremony held in Albany, Dr. F. Karl Willenbrock, Director of the Institute for Applied Technology, presented the set to Dr. T. Norman Hurd, Secretary to Governor Rockefeller, who accepted on behalf of the Governor.

OSHA-NBS Agreement Set

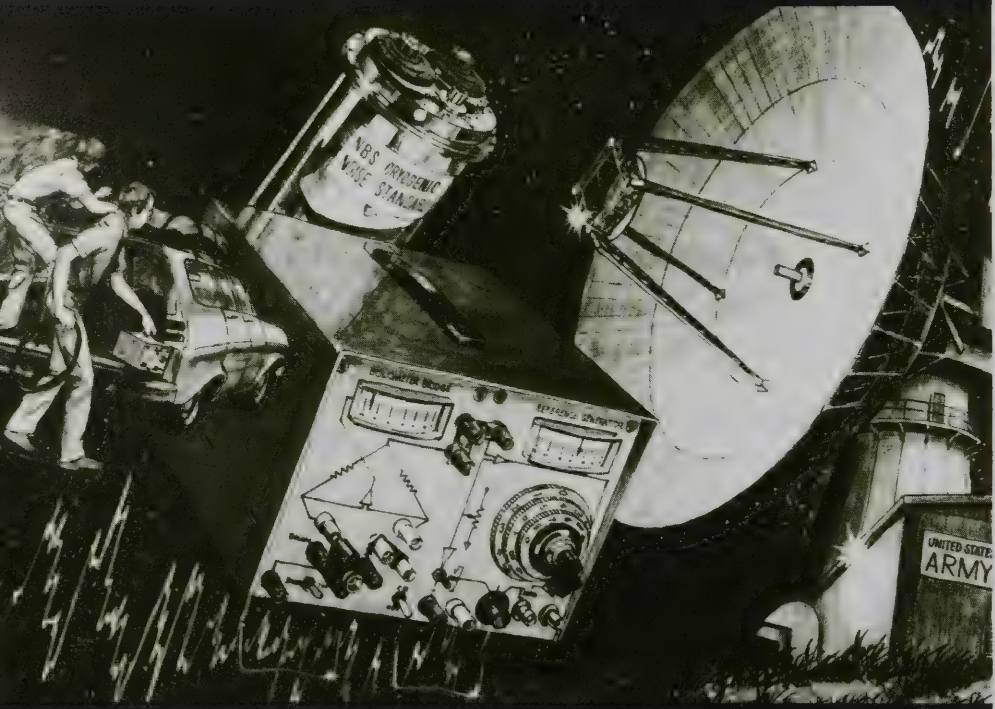
NBS will furnish technical assistance and perform scientific research for the Occupational Safety and Health Administration (OSHA) of the Department of Labor under an agreement signed by the two agencies. These NBS services will include: Conducting scientific investigations in connection with failures or disasters under OSHA's enforcement jurisdiction and helping coordinate activities of Bureau representatives on various standards-setting groups in areas of interest to OSHA. □

STARRY-EYED NBS'ERS DO THE UNUSUAL

SCIENTISTS of the Bureau's Boulder Laboratories have put in a 10-night stint for the U. S. Army, operating the Army's satellite-communications ground station at Camp Roberts, California.

Situated north of Paso Robles and 15 miles west of highway US 101, this ground station, usually operated by the U. S. Army Strategic Communications Command, serves as a direct link with military units in the Far East. But why were NBS personnel venturing so far from their Colorado laboratories and operating an Army satellite-communications ground station, not to mention the unusual hours?

In this case, the Army wanted their recently upgraded ground-station facility evaluated in a matter of weeks to determine whether or not it measured up to its claimed performance. The job order wasn't the type that could be done in the lab nor was there time to study the problem extensively. NBS knew the Army wouldn't be satisfied with a theoretical computation so the alternatives were clear. A rented vehicle was loaded with the necessary NBS instrumentation, and a crew of experts on noise measurements headed for California. Limited time prompted part of the NBS crew to personally trans-



A radio star, background sky temperature and a Y-factor measurement method enabled NBS scientists to evaluate the site's satellite communications system.

port the delicate equipment, thus eliminating possible damage and delays.

Headed by Charles K. S. Miller, the team of four, including William C. Daywitt, David F. Wait and John P. Wakefield, arrived at Camp Roberts and set up to measure the gain-temperature-ratio (G/T) utilizing the NBS Automatic Y-Factor Measurement System and two radio stars which served as standard noise sources.

G/T is a figure of merit that expresses the performance rating of a communication receiving system designed to receive very weak signals from a point source in space. The G/T ratio measurement to be made by NBS was intended to calibrate the ground station in order to provide the basis for determining the effective radiated power (ERP) of a communication satellite and to quantify the degree of success achieved in the upgrading effort.

The Army, needing a totally impartial measurement, called on the NBS Electromagnetics Division in Boulder, Colorado, to help them. However, only four weeks were allowed to complete the job. After two weeks of preparations, wherein modifications were made to the existing NBS measuring system, the crew of four loaded a station wagon with carefully packed precision measuring instruments, drove to California, made their measurements and reported the results to the Army personnel in command, all within the stated timeframe.

Because the ground station was operational during the day, the NBS team had access to the system only during the night hours. The four men split into two teams, each working half the night. During the day they reduced and evaluated the data and, to avoid lost time, prepared for their nighttime sojourn.

Heart of the NBS measurement instrumentation is the recently developed computer-controlled Y-factor system. By pointing the 60-ft. dia. Cassegrain antenna at the "cold" sky and then at a radio star, the two noise-power levels were measured using the NBS Type II self-balancing bridge, the most accurate power-measurement bridge known. The two measurements yield a ratio termed the Y-factor. A computer then processed the Y-factor figure and read out G/T directly.

In spite of the unusual conditions under which the crew worked, they delivered to the Army the results of the measured G/T ratio *on time, on site!* ☐

FACILITY GENERATES PARTS PER BILLION HUMIDITY

THE Bureau is now operating a humidity calibration facility for instruments that measure trace amounts of water vapor—a matter of increasing concern in industrial and scientific areas, including nuclear reactors and stratospheric research. The facility was built with the support of the Viking Project Office of National Aeronautics and Space Administration.

Lewis Greenspan, an NBS physicist, has developed a humidity generator that will produce accurate frost points down to —100°C (14 parts of water per billion parts of air at atmospheric pressure) at ambient pressures from 500 to 200,000 pascals (5 to 2026 millibars) over a wide temperature range.

The new NBS facility is available for testing hygrometers used in high-temperature, gas-cooled nuclear reactors where the moisture content of high-pressure helium has to be controlled to prevent destruction of the graphite-clad fuel elements. Calibration can be performed on devices used to measure moisture in atmospheres of other planets hundreds of millions of kilometers away. And, closer to home, this facility can calibrate the instruments used to determine the humidity of the stratosphere and mesosphere. Accuracy in these measurements is necessary to better understand photochemical and transport phenomena and their effects on climate.

The humidity facility is a dynamic flow system which produces a gas stream of known moisture content. Within the apparatus a heat exchanger is used to bring the test gas stream to the temperature of a constant-temperature liquid bath. Test gas comes into contact with, and is saturated by, a film of ice on the inner surface of a long helical coil.

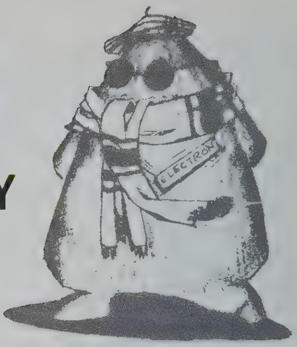
Because the mass of water vapor required to saturate the test gas stream at low temperature is very small, the temperatures of the gas and the inner ice surface are not significantly perturbed by the latent heat evolved during sublimation. The temperature of the gas at the exit end is therefore very close to the saturation temperature, the frost point of the test gas stream.

The uncertainty of the humidity of the test gas depends on how accurately temperature and pressure can be measured and the behavior of the gases involved during a determination. When these uncertainties are taken into account, it is estimated that the maximum frost-point error probably does not exceed 0.05°C.

This new NBS humidity calibration facility has been successfully operated over a wide range of conditions, Greenspan says. It is available for calibration, testing and research on humidity sensors and hygrometers, particularly those capable of detecting moisture contents down to the parts-per-billion range. ☐

AIR POLLUTANTS

MEASURED USING ELECTRON SPECTROSCOPY

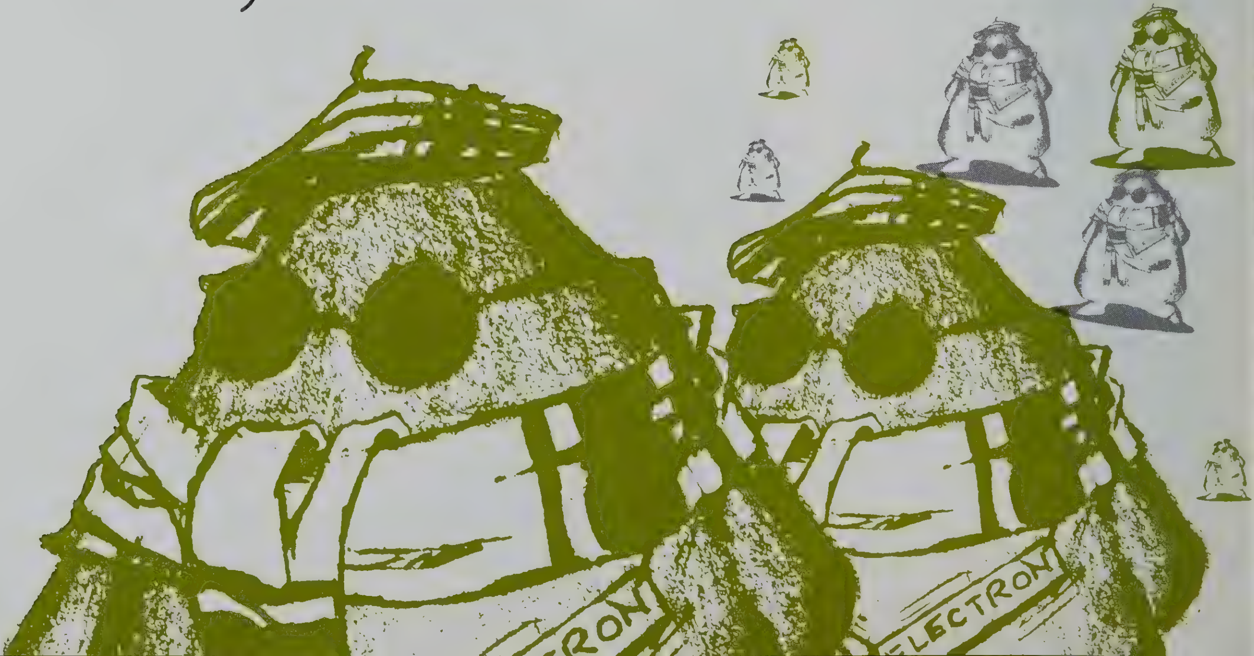


Air pollution is now detected by Bureau Scientists using monoenergetic (or cool) electrons

AIR pollutants can now be accurately measured using sophisticated electron spectrometric methods developed at NBS.

Dr. Chris E. Kuyatt, Dr. Robert J. Celotta and Stanley R. Mielczarek of the Optical Physics Division say their new device is the first of its kind in use.

Despite the fact that there are faster gas analyses available to determine any one component in a gaseous mixture, the researchers indicate that their method is better when a complete analysis is required. Designed to make use of inelastic electron scattering measurements, the energy distribution (energy loss spectrum) of the electrons reveals the valence energy states of the gas which is an



intrinsic "fingerprint" of the atom or molecule.

The principle of impact spectroscopy says that when an atom or molecule is bombarded by an electron beam of sufficient energy an energy transfer may occur. If this transfer occurs, the "target" (pollutant) becomes excited and the impacting electron deviates from its original course, suffering an energy loss. This loss is exactly equal to the energy gap between the ground state and the final excited state. If the original impinging electron beam is monoenergetic, a spectrum can be obtained with a discrete energy loss in the beam corresponding to every possible energy state in the atom or molecule.

A few years ago Dr. J. A. Simpson, also of the Optical Physics Division, recognized that new electron spectrometer designs could make gas analyses possible. Inelastic scattering methods have been shown to have sensitivities of better than 50 parts per million (ppm) of carbon monoxide in air and 100 ppm of nitrous oxide, nitric oxide and carbon monoxide when simultaneously present in air. With helium as a carrier gas, hydrocarbons such as acetone, trichloroethylene, benzene and n-hexane have been measured, both separately and in combination, with a sensitivity of a few ppm. The sensitivity of the technique is dependent upon the shape of the "fingerprint" being searched for. Mercury, which has a distinct shape, can be detected at less than the 0.05 ppm level.

While simplifications of design and operation are achievable, it is more likely that this type of apparatus will be used mainly in a laboratory environment, its developers say. Even so, a commercial model of this apparatus, a past Industrial Research Institute award winner, is being marketed and is now in several major laboratories. Combinations of the commercial apparatus and various pre-filtering techniques, such as gas chromatography, are now being explored at NBS. ☐

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Publications listed here may be purchased at the listed price from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 (foreign: add 25%). Microfiche copies are available from the National Technical Information Service, Springfield, Va. 22151. For more complete periodic listings of all scientific papers and articles produced by NBS staff, write: TRA, Room A640 Administration Building, National Bureau of Standards, Washington, D.C. 20234.

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